March 21, 2012
Pfeiffer

East Mamm Creek Project Area Technical Review

Situation

Citizen complaint regarding current and past drilling practices causing seep in 2004 and 2008; COGCC study on drilling and cement investigates 2004 seep.

Three Topics

1. Lisa Bracken concerned about data gaps in on-going study; the 2004 and 2008 seep area and the Bracken water well have not been included in the sampling events (confirm this).
2. The COGCC conducted a study in the area; this report under review to determine if adequate drilling and cementing practice are being required.
3. EPA identified poorly constructed wells that were potential conduits for gas migration; a random review of the well files conducted to determine if remediation conducted

Bracken Primary Concerns per emails

1. 2008 seep not being investigated (need confirmation)
2. Bracken seep and water well have been excluded from both Phase I and II of the study (need confirmation)
3. 2004 seep cause not identified and still active: benzene and other toxics being released into shallow aquifer of West Divide Creek that supplies domestic and agricultural water and major tributary of CO River

COGCC Response to 2004 Seep

1. East Mamm Creek Project Drilling and Cementing Study-Conclusions (June 20, 2011):
    - Concluded several non-commercial gas zones in shallow horizons; shallow gas sands are scattered throughout the area
    - Shallow gas zones exist and must be isolated
    - Top of Gas (TOG) is not defined and could be defined as commercial TOG
    - Determines NTO's (Notice to Operators) effective in mitigating natural gas migration into surface water and groundwater resources
    - Each well must be engineered specifically; conditions are variable
    - Kickoff at shallow depths in surface casing section has lead to deviation in hole, increasing tendency for casing to lie on the low side of the open hole—"leading to various conditions resulting in incomplete zonal isolation of surface casing hence forming a conductive path for fluids to cross-flow from one stratum into another along the surface casing cement sheath"
    - Lenticular gas bearing sands conducive to drilling fluid losses and flows
    - Remedial cementing has been effective
    - BH pressure not always reflective of poor cement (indicates 'flow' between formations and through USDW to reach surface; need to investigate violation under COGCC construction rules)
    - Reviewed 31 wells; 15% wells experienced significant losses (>300 bbls mud); equal number had measurable gas flows
    - In wellbores cemented to surface, continue to see poor bonding in shallow portions of well Natural fractures potentially exist
    - Through microseismic (HF) fracture mapping, height growth 200 ft and lateral extent couple of hundred feet (given cementing issues, could (HF) fractures be traveling up backside of neighboring wells?)

Well Reviews (31)

- Gas flows (indicative of underbalanced drilling), lost circulation, bradenhead pressure, ratty cement jobs,
- Arbaney Event: Magic 10-2; March 2004; elevated gas in drilling mud at 3,300 ft; mud returns diverted from flowing to pit switched to return lines through gas buster; system plugged and pressure built up; 300 psi noted behind choke but could have reached 1,200 psi; two explosions; controlled "fire ball"; remedial cemnt job on surface casing; BH <20 psi

Recommendations (need to review drillers report for new drill)

- Surface Casing: Develop a SOP for cementing surface casing (similar to production casing SOP)
- Casing deviations: Operators should perform centralization calculations prior to all surface casing cementing efforts
- Surface Casing Cement: Use a lead slurry system in all EMCPA surface casing jobs to minimize cement fall back
- P&A: Modify COGCC policy for surface casing shoe plugs to require 100 ft in and outside of casing
- Federal TOC (200 ft above Mesa Verde) used by Encana (this doesn't address shallow gas zones)

2. Cementing NTO: Drilling in the Mesaverde Group or Deeper in the Mamm Creek Field Area in Garfield County, Well Cementing Procedure and Reporting Requirements (July 23, 2004; revised February 9, 2007)
   - Cement required 500 ft above TOG (need to determine how TOG being defined)
   - TOC to be determined by CBL
   - After 1° cementing operation, report annular fluid and mud loss >20 bbls
   - Bradenhead (BH) pressure monitored up to 72 hours after cement job; report >150 psig and remediation strategy required
   - CBL required in East Mamm Creek Area with 12-48 hours after cement job
3. Bradenhead NTO: Drilling Wells in the Buzzard, Mamm Creek, and Rulison Fields, Garfiled County and Mesa County, Procedures and Submittal Requirements for Compliance with COGCC Order NOS. 1-107, 139-56, 191-22, and 369-2 (July 8, 2010)
   - All annulus must be accessible
   - Annual testing for pressure and flow
   - 1,000 psig gauge required; report >150 psig or continuous flow of liquid
   - By Nov 1: report all annual bradenhead data on spreadsheet (can we get this?)
   - For consistency, well shut-in (7) days prior to conducting test; must bleed of prior to reaching 150 psig and report actual shut-in time
   - Venting (ie keeping BH open full time) and continued monitoring is typical mitigation step (can we find out what wells are currently under mitigation?); combustors encouraged
   - If >150 psig, high flow rates, or significant fluid (mud or water) then remediation a consideration
   - Sundry Notice approval required prior to venting
   - Sundry Notice required prior to remedial cementing; 30 day grace period for venting as needed

EnCana Response to 2004 Seep

1. SOP: EnCana Cementing SOP-Casing Running Procedures (November 22, 2006)
   - Production Casing Running Procedure (reviewed and they are excellent)
   - Production Casing Cementing Procedure (reviewed and they are excellent)
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2. Internally, TOG is now changed to "Top of First Gas Show"

USGS Findings

1. Biogenic gas exists in Wasatch Formation

EPA Findings

1. All of the wells investigated under the study were included on EPA's list identifying 'trouble' wells
2. Not all wells identified by EPA were part of the 31 wells in the study
3. Random review of 5 wells that were not part of the study and drilled pre-NTO that were identified as having shallow gas migration by EPA (and currently venting)—none have under gone remediation
4. Under permit conditions, continue to reference X+50 within 1 mile radius for surface casing requirement

Current Status

1. 2010 soil gas survey by EnCana mapping methane expression on Lisa's property; she would like a follow up sampling event for comparison
2. Federal government requires TOC 200 ft above the Top of the Mesa Verde or Ohio Creek Sands; this is not adequate given the shallow gas zones—(should we have discussions with BLM)

Big Picture Questions:

Exemption (b) (5) Deliberative Process

Follow-Up Needed

1. Is the Malina laterally extensive